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ANALOGY BETWEEN LARYNGEAL GESTURE AND ACOUSTICS IN MONGOLIAN LONG SONG AND PARTIAL LARYNGECTOMY

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Objective. This paper presents the results of a multiparametrical analysis of "Mongolian Long song", named *Urtyn duu* in Mongolian. This is a long and slow versified melody with multiple ornamentations, which are unknown in the western occidental singing. The laryngeal behaviour observed during certain ornamentations can be compared to compensatory gesture produced by patients after partial laryngectomy. The aim of this study was to (1) analyse different laryngeal gestures and their acoustic correlate in Mongolian Long Song and to (2) understand compensatory behaviour used by patients without vocal folds (substitution voice) at the supraglottic level with aryepiglottic folds. We try to know if the laryngeal movement observed during Long Song relates to a physiological production or extreme movements in the field of degree of freedom of the larynx.

Method. The study includes: (1) a physiological analysis (videofiberoptic laryngeal data of the 61 ornamentations of a song produced by a famous Mongolian singer, Narantuya, and video recordings of the singer); (2) an acoustical analysis (fundamental frequency and intensity curves of the ornamentations), (3) analysis of videofiberoptic recordings of 3 patients after supra cricoid partial laryngectomy.

Results. The fiberoptic analysis, inspired by Edmondson *et al.* one (2006), showed two main laryngeal behaviour in producing ornamentations, with a leitmotiv: (1) "lyrical" vibratos mobilizing the entire laryngeal block; (2) "Mongolian" trills with essentially supraglottic movements, the arytenoids being mobilized independently of the rest of the laryngeal block. Furthermore, there is a basic movement of closure of the vocal folds and the participation of interarytenoid muscles and ary-epiglottic folds creating an anteroposterior vibration. This mechanism corresponds to the so called "pressed phonation". These movements are observed in patients after supra cricoid partial laryngectomy to create a vibrating neoglottis (Crevier-Buchman, 1999). The acoustical results in Mongolian singing are high pitch and modulated melody while the patients have low pitch and monotonous speech. These movements contrasted with the absence of cervico-scapular movement of the singer producing a long song during a concert.

The acoustic analysis (Dromey *et al.*, 2003) showed: (1) for the "lyrical" vibrato: the fundamental frequency and the intensity were in-phase, with a moderate amplitude (1 to 3 semitones for the fundamental frequency, 4 to 6 dB for the intensity; 5 to 6 modulations/s); (2) for the "Mongolian" trill: the fundamental frequency and the intensity were in opposite phase, with an important amplitude (3.5 to 4.5 semitones for the fundamental frequency, 6 to 10 dB for the intensity; and 6 to 7 modulations/s) and acoustical indications of changes of laryngeal vibratory mechanisms (Castellengo *et al.*, 2007).

Conclusion. In this multiparametrical study of Mongolian Long song with previously unpublished physiological data, we defined two ornamentations used by the singer in the same melody, corresponding to different laryngeal movements and different acoustic characteristics: "lyrical" vibrato and "Mongolian arytenoidian" trill. The use of supra-glottic articulation corresponding to the "Mongolian" trill can be seen in patients after supra cricoid partial laryngectomy to compensate the lack of glottic vibration.

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